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FEBRUARY 1963

The Economic Feasibility Of Additional Milk Manufacturing Facilities In North Carolina

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PREFACE

This study was undertaken at the request of and for the benefit of members of the milk industry of North Carolina. It is hoped that the information contained in this report will aid the industry in making more rational economic decisions in this time of rapidly changing supply and demand conditions.

The author acknowledges the help of the manufacturing equipment representatives for aid in estimating costs of operating the plants analyzed. Appreciation is expressed to the various plant managers in North Carolina, Pennsylvania and New York for their cooperation in supplying accounting data and information contributing to the completion of this study. The cooperation of the North Carolina Milk Commission in supplying data is gratefully acknowledged.

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SUMMARY

This study investigates the economic feasibility of constructing and operating manufacturing facilities to handle current and prospective supplies of surplus milk. The types of plants considered are a specialized cheddar cheese plant with a 10,000-gallon processing capacity per eight-hour shift, and a butter-powder plant with an eight-hour processing capacity of 20,000 gallons. The central question which was answered is this, "Can a manufacturing plant operating under the economic conditions currently prevailing in North Carolina afford to pay a competitive price for raw Class III milk, process it into manufactured products, sell the products on a competitive product market, and still realize a reasonable return on the capital invested?"

To answer this question, five major analytical steps were completed:

1. The value of the various products obtainable from 100 pounds of raw milk was estimated using competitive product prices. The value of butter and nonfat powder averages $4.13 per cwt. of raw milk. The value of cheese per cwt. of raw milk averaged $3.88.

2. The market price for surplus Grade A milk was determined from current transactions with existing manufacturers. This price averaged $3.20 on a fat corrected basis during 1961.

3. The price of raw milk was subtracted from the value of the finished products to obtain an estimate of gross processing margin. The estimate of the gross margin for the butter-powder plant was $.93 per cwt. of milk. The margin for cheddar cheese was $.68.

4. An estimate of processing costs was made for various operating conditions. Based on the seasonality of supplies of surplus milk in 1961, processing costs for the butter-powder were estimated at $.60 per cwt. Cheddar cheese processing costs were estimated at $.73 per cwt.

5. Processing costs were compared with gross operating margin to estimate expected profits. Profit margins were estimated at $.34 per cwt. for the butter-powder plant and $.07 for the cheddar cheese plant.

The results of the analysis indicated that a cheddar cheese plant selling uncured 24-pound hoops on the wholesale markets had expected profits of $.07 or less per hundredweight of raw milk received. This is a fairly low return and probably should be considered a poor investment risk unless the cheese can be further processed into higher valued products. This possibility was not further analyzed.

The butter-powder plant appears promising at present quantities of surplus milk, present product prices and raw milk prices. Estimated profit margins averaged about $190,000 per year, or $.34 per hundredweight of raw milk. This margin should be adequate to bid successfully for the milk. Increases in surplus milk supplies will make the feasibility of the plant even greater. Although surplus milk supplies are quite seasonal in nature, the feasibility of the butter-powder plant is not seriously affected because labor requirements are low. Problems of laying off and rehiring workers would not be serious. Further investigation among industry groups as to possible ownership structures and pooling arrangements appears warranted.

The Economic Feasibility Of Additional Milk Manufacturing Facilities In North Carolina

INTRODUCTION

Purpose of Study

Recent increases in Grade A milk supplies in North Carolina beyond fluid requirements and present processing capacity have resulted in substantial quantities of milk being sold to cheese and evaporated milk plants in neighboring states. The existence of these "standby" markets has been beneficial to North Carolina distributors in providing an outlet for surplus milk. However, it is possible that additional manufacturing facilities in this state would return a higher value for milk than is now received from the evaporated milk and cheese plants. Also, there are some indications that these existing plants may not be able to handle substantial additional quantities should the production of milk in North Carolina continue to increase at a faster rate than consumption. For these reasons, members of the milk industry in North Carolina have given considerable thought to the economic feasibility of an additional manufacturing milk plant located in the Piedmont region of the state. This study investigates the economic feasibility of such a plant.

Scope of Study

Many types of manufacturing plants might be considered. A whole milk cheddar cheese plant might be feasible. A butter-powder plant is another possibility. The number of combinations of products which could be processed from a butter-powder plant are numerous: (a) butter and nonfat dry milk, (b) butter and condensed skim, (c) butter and cottage cheese, (d) cream and nonfat dry milk, (e) cream and condensed skim, (f) cream and cottage cheese, (g) ice cream mix, and (h) a diversified plant equipped to produce all of the above products.

In this study only two types of plants were analyzed, a butter-powder plant and a cheddar cheese plant. The butter-powder plant analysis was completed for a plant of 20,000 gallons of raw milk processing capacity per 8-hour shift. Provision was made for the sale of fluid cream and condensed skim to such an extent as these markets may be available. Although it would have been interesting to investigate the feasibility of plants of varying sizes, only a single size was considered. Plants smaller than this were considered not feasible because of their inability to use efficient, large capacity equipment. Considerable economies of scale are available in butter-powder plants up to and beyond the one considered in this study.[1] Smaller plants could not compete on a national butter-powder market in case it became necessary to resort to these outlets. Larger plants than the one considered here would probably show more promise of profitability but current and prospective surplus milk supplies do not warrant a larger plant at this time. The plant considered here could handle a half million pounds of milk per 24-hour day, which is sufficient capacity to process all of the surplus milk available in North Carolina in 1961.

The cost and revenue picture of a multiple products plant such as the one considered here depends on the proportion of the various products manufactured and sold. This, in turn, depends on the ability of the plant to sell the butterfat in the higher valued fluid cream market and avoid the lower priced government supported market. The success of the plant in securing advantageous fluid cream sales will affect its profit account. In order to avoid postulating the bargaining effectiveness of a plant whose management does not yet exist, the economic feasibility of the plant is appraised under conditions ranging from the sale of all of the fat at support prices to the sale of a large proportion of the fat as fluid cream at higher prices.

The specialized cheddar cheese plant was completed for a plant capacity of 10,000 gallons of raw milk per 8-hour shift. Consideration of larger sizes probably would not have affected the estimate of the profitability of new cheese production facilities. It has been shown that a plant of the size considered here attains most of the cost economies available to larger plants.[2]

Other product possibilities were omitted from the analysis for various reasons. For example, cottage cheese and ice cream mix were not considered because the products are not standardized and each plant normally prefers to make its own.

While the profitability of a proposed plant may depend in part on its management-ownership structure, these factors are not included in the analysis. The scope of the study is limited to the estimation of processing costs under standard operating conditions. Problems of merchandizing were not considered. It was assumed that product markets and raw milk supplies would be readily available to the prospective new plant at competitive prices.

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[1] Glen T. Nelson, Input-Output Relationships in Specialized Butter-Powder and Cheese Plants, Oregon Agr. Exp. Sta. Bulletin 32, 1956.

[2] Ibid.

Method of Analysis

The economic feasibility of a manufacturing plant depends on its ability to process milk efficiently enough to pay a competitive price for raw milk and still sell successfully on competitive product markets. If a new plant operating in this environment can return enough net revenue to repay the initial investment plus a reasonable rate of return, the plant will be considered economically feasible.

The analytical procedure involves five major steps:

1. Estimating the value of the various products obtainable from 100 pounds of raw milk of average fat content and the total revenue obtainable by producing the selected products in various proportions. Products are priced at f.o.b. North Carolina prices for products currently available from out-of-state sources.

2. Estimating the market price for various quantities of surplus Grade A milk as indicated by the prices for Class III milk paid by existing manufacturing plants.

3. Subtracting the price of raw milk from the value of the finished products to obtain estimates of the gross margin available to cover processing costs.

4. Estimating the processing and handling costs for the various products under specified operating conditions.

5. Comparing the processing and handling costs with the gross operating margin to estimate expected profits.

AN APPRAISAL OF GRADE A MILK SUPPLIES

Trends in Grade A Milk Production

Since the feasibility of a plant depends in large part on the quantity and seasonality of prospective supplies, it might be well to discuss current and expected future trends in production. The discussion of present trends in Grade A milk production is divided into two parts: (1) trends during the period 1948-1954 and (2) trends during the period 1954-1961. These trends are indicated in Table 1. The period of 1948-1954 was characterized by rapid increases in the number of Grade A producers, slight increases in average producer size, and rapid increases in Grade A sales to distributors. During this period, the number of producers more than doubled, average producer size increased 27 percent, and total Grade A sales increased by 160 percent. During this period North Carolina became self-sufficient in

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Table 1. Recent trends in the supply of Grade A milk in North Carolina

Year	No. of Grade A producers[a]	Average daily production per producer (lbs.)[b]	Grade A purchases from producers by N. C. distributors (million lbs.)	Fluid milk and cream sales (million lbs.)	Class III sales by N. C. distributors (million lbs.)
	(1)	(2)	(3)	(4)	(5)
1948	2544	276	256	335	c
1949	3387	275	340	361	10
1950	4053	289	427	421	12
1951	4368	304	485	478	10
1952	4664	307	523	535	3
1953	4742	354	613	553	22
1954	5182	352	665	579	65
1955	5167	365	689	627	38
1956	4974	418	759	668	49
1957	4805	477	837	701	80
1958	4674	490	836	715	64
1959	4430	557	901	765	74
1960	4205	625	960	794	95
1961	3984	724	1,038	791	164

[a] Figures pertain to January of each year.
[b] Column 3 divided by column 1 and divided by 365 days.
[c] Insignificant amount.

Source: North Carolina Dairy Report, various issues.

fluid milk needs, imports of milk having decreased from 25 percent of needs in 1946 to less than 3 percent in 1954. Most of the milk ingredients for ice cream production were still imported in 1954, however.

The reasons for this rapid expansion in milk production, as indicated by previous research 3/ were: (1) increases in the fluid milk-feed price ratio, (2) higher labor prices, which affected tobacco and cotton enterprises more than dairy, and (3) technical changes which lowered dairy and feed production costs relative to tobacco and cotton production costs. The factors caused many farmers to switch to dairying from other enterprises.

During the period 1954-1961, different economic forces came into focus. The number of Grade A dairy producers decreased 23 percent.

3/ J. E. Faris and W. W. McPherson, Adjustments in Milk Supply, Grade A Dairy Farms, North Carolina Piedmont, N. C. Agricultural Experiment Station Technical Bulletin 136, January, 1959.

However, average production per farm doubled, and Grade A purchases by distributors increased by 50 percent. The decrease in number of producers was caused in large part by technological changes in milk production which required substantial investment in equipment--bulk tanks, for example. Rather than make the large investments required, many producers switched to other enterprises. Those who remained in production and invested in new equipment expanded sharply in size in order to justify the capital expenditure. Thus, total production increased considerably during this period despite decreased numbers of producers. This trend was typical throughout much of the United States.

During the entire period from 1948-1961, production increased an average of 13.1 percent per year while fluid milk and cream sales by North Carolina distributors rose an average of 7.5 percent per year. These differential rates of growth were reflected first in the decreasing quantities of fluid milk imported, then in the increasing use of local milk for the production of ice cream and other minor manufactured products and finally in the sale of Grade A milk to out-of-state manufacturing plants. Present quantities of milk shipped to evaporated milk and cheese plants are indicated in Table 2.4/ Further production increases in excess of consumption will cause still larger shipments to out-of-state manufacturing plants as long as such markets are still available.

Although large quantities of Grade A milk are exported to manufacturing plants, equally large quantities of nonfat powder, condensed skim and fluid cream are imported for the manufacture of ice cream. Table 2 shows the 1961 monthly volume of these imports in terms of milk equivalent.

Prospects for Further Increases in Milk Supply

The period of rapid entry in response to moderate changes in the relative prices of commodities is probably over. The heavy initial investment required to produce milk will effectively retard entry. Consequently, production increases from new producers are unlikely. However, forces tending to increase production per farm are still strongly present. Substantial increases in production per cow can be expected as breeding programs for established producers get more fully developed. Average production per cow is still well below production rates in leading dairy states. There is considerable pressure on the part of many producers to increase herd sizes and obtain lower production costs through more efficient use of labor and equipment. So total Grade A production probably

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4/ Records now available for the period January through July of 1962 indicate that sales to manufacturing plants are 13 percent higher than existed for the same period in 1961.

Table 2. Sales of Grade A milk to manufacturing plants and purchases of milk products by North Carolina distributors, 1961

Month	Total Class III sales (1)	Total sales to manufacturing plants (2)	Milk equiv. of N. C. cream imports (3)	Milk equiv. of condensed skim imports (4)	Milk equiv. of powder imports (5)
Jan.	10,510	3,664	180	1,060	2,203
Feb.	8,283	2,818	100	920	3,455
March	10,515	3,700	500	1,937	3,320
April	16,304	5,879	800	1,582	2,357
May	17,881	7,873	1,073	1,202	1,335
June	13,722	5,990	2,335	1,651	3,556
July	13,557	3,417	3,118	1,977	4,006
Aug.	13,993	3,584	2,770	2,047	3,171
Sept.	9,097	2,482	2,255	2,568	3,676
Oct.	14,046	2,920	1,000	2,000	3,000
Nov.	14,767	4,613	458	1,700	2,921
Dec.	21,508	8,818	228	592	1,516
Annual total	164,183	55,758	14,817	19,263	34,516

Source: North Carolina Milk Commission Records.

will continue to increase even at present price levels. The exact rate of increase in the future depends on many factors and is difficult to predict accurately.5/

Fluid milk and cream sales will probably continue to increase in response to higher incomes of consumers, population increases, and the decrease in "family cow" milk production. The rate of increase in consumption will probably average about 3 percent per year.6/ Grade A production will probably increase at a rate faster than 3 percent per year for some time. Hence, the excess of Grade A milk above fluid

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5/ A mail questionnaire returned by 54 percent of all Grade A producers indicated that producers expected to increase production by an average of 25 percent in the next two or three years.

6/ Increases in consumption for North Carolina are estimated at an average rate of 2 percent per year by J. C. Purcell, Prospective Demand for Milk and Milk Products in the South, Southern Cooperative Series Bulletin 68, October 1959. Fluid milk and cream sales will probably increase at a slightly faster rate than consumption due to decreases in production by "family" cows.

milk and ice cream needs may be increased in the future.[7] The loss of military contracts or chain store sales to outside interests could also add substantially to present surpluses.

Seasonal Distribution of Surplus

The seasonal distribution of quantities of excess milk is quite distinct as can be seen in Table 2. Months of peak sales to manufacturing plants are April, May, June, and December. Surpluses in the spring months result from flush pasture conditions and the December surplus is due primarily to loss of school sales. Marked seasonal variation in supplies can mean high processing costs in plants which have large labor forces to maintain. Variable supply conditions are not serious in automated plants.

Geographical Distribution of Supplies

The location of present and future milk surpluses can be an important factor in affecting the feasibility of a processing plant. Locating the plant near the center of the major surplus areas would add to its profit potential by keeping assembly costs low. The present location of surpluses at the various bottling plants is indicated in Figure 1, which shows the origin and movements of surpluses in May, 1961.

The location of at-farm surpluses is somewhat different. If direct diversion from farm routes to the prospective plant is possible, the location of at-farm surpluses is important as well as the location of at-plant surpluses. Figure 2 shows the present pattern of Grade A milk production. Large quantities of milk are produced in the Piedmont centered in the Rowan, Davie, Iredell county area. This location would appear to be appropriate for a single plant. If two plants were feasible, the two locations would be somewhat different. Present quantities of surpluses appear sufficient for only one plant. Hence, the plant probably should be located in the Thomasville, Salisbury, Lexington area, depending on local utility rates, tax laws, and road access. This location would be appropriate whether milk is diverted from farm routes or received at the plant and later diverted.

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[7] It is important to note that small percentage increases in Grade A production above fluid sales can increase surplus milk sales by large percentages. This is because most of the increases in production must move into surplus channels. Thus, a 10 percent increase in production of Grade A milk may increase sales to manufacturing plants by as much as 25-30 percent.

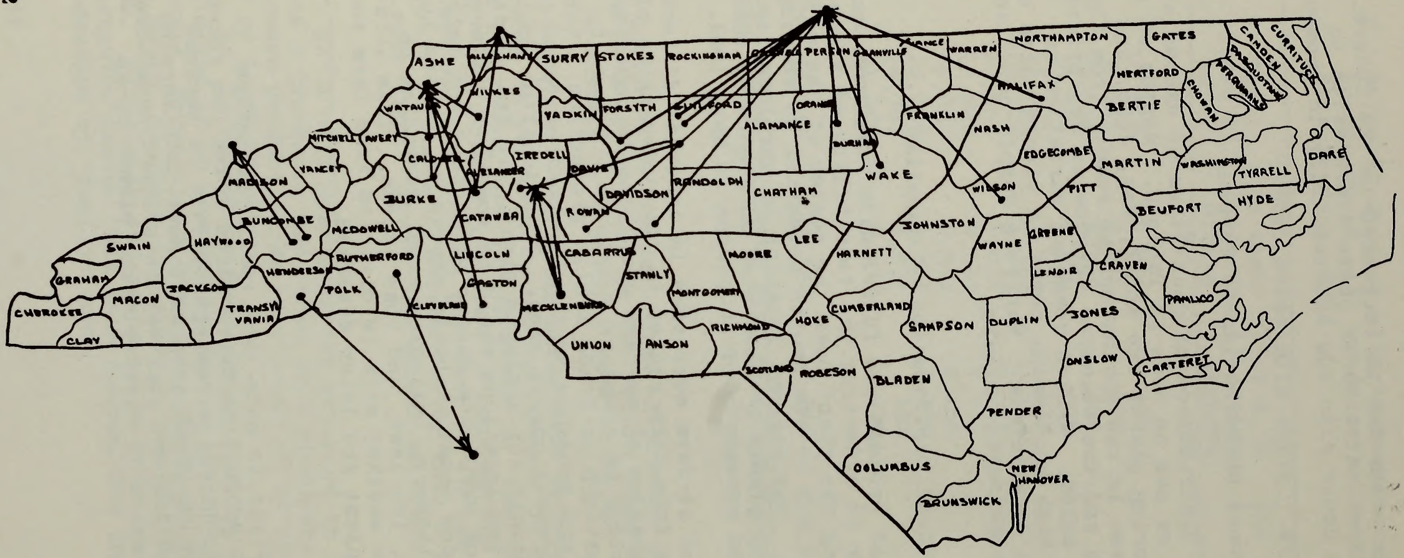

Figure 1. Sales of milk to manufacturing plants by source, May, 1961

Source: North Carolina Milk Commission records.

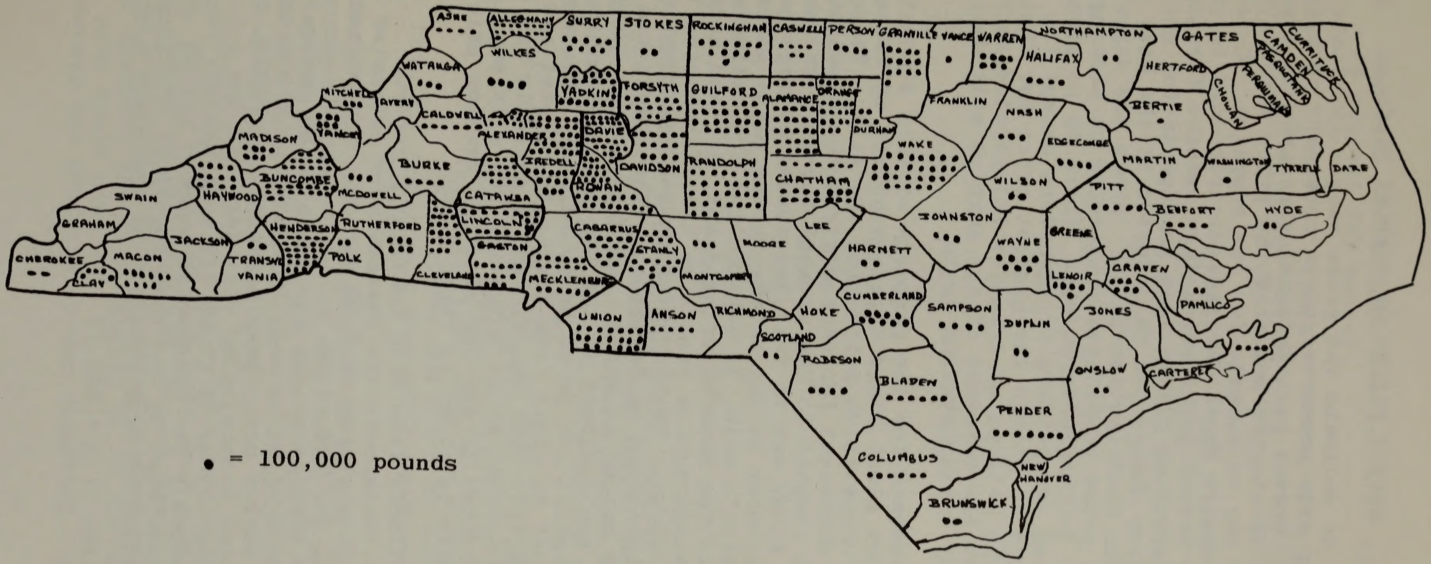

Figure 2. Production of Grade A milk by counties, September, 1961

SUPPLY PRICES OF SURPLUS MILK

In order to estimate the gross margin available to process and distribute milk products, it is necessary to place a value on raw milk. Current institutional arrangements for pricing Class III-A milk obscure somewhat the price which a new plant would have to pay to compete for raw supplies. Current regulations require North Carolina distributors to pay producers the actual price which they receive for the milk sold to manufacturing plants less transportation costs. Also, a small handling charge can be deducted if the milk is actually received at the distribution plant. Since the distributors cannot retain price advantages obtainable by seeking the highest price for transferred milk, there is no mechanism for determining the pattern of transfers except the desire of distributors to obtain the highest price for their own producers. The pattern of transfer illustrated in Figure 1 indicates that the movement of the surplus milk does tend to be affected by transportation costs.

It was assumed for the purposes of this study that a prospective new plant could obtain supplies of raw milk only by paying a "competitive price" for the milk. The competitive price may be different for each distributor depending on his location with respect to his present buyers. The procedure used in this study was to take the annual average price paid to each distributor by the manufacturing plant normally buying that distributor's milk, 8/ subtracting the estimated transportation cost to the manufacturing plant, 9/ and adding the estimated transportation cost from the distributor to the proposed new plant. The location of the new plant was arbitrarily specified as Salisbury. The result was an estimated "supply price" at which each distributor now having surplus milk would divert to the new plant (assuming he wanted the highest net price he could get). By arraying the "supply prices" in order from lowest to highest and accumulating the respective 1961 quantities, a schedule was developed representing quantities of potential raw milk supplies which could be attracted to the new plant at varying prices. This supply schedule is given in Table 3.10/

8/ Available from Milk Commission records.

9/ The transportation charges were estimated by assessing a fixed handling charge of $.10 per cwt. and an added cost of $.15 per cwt. per 100 miles.

10/ The monthly prices for raw milk as estimated by this procedure would actually vary by months as the butterfat content and market price vary seasonally. Hence, this supply schedule cannot be projected very far into the future. However, changes in the prices of Class III milk usually result from and follow closely the changes in support prices of products. If these prices move up and down together, the gross processing margin and expected profitability of the plant will be unchanged.

Table 3. Supplies of raw milk available at various prices[a] (4 percent fat basis)

Price (dollars/cwt.) (1)	Supply (1,000 pounds milk) (2)	Cumulative supply (1,000 pounds milk) (3)
3.13	4,594	4,594
3.18	10,662	15,256
3.19	5,254	20,510
3.19	3,310	23,820
3.21	667	24,487
3.21	1,387	25,874
3.25	719	26,593
3.25	1,336	27,929
3.25	1,952	29,881
3.30	106	29,987
3.33	935	30,922
3.36	328	31,250
3.39	1,477	32,727
3.39	1,147	33,874
3.41	5,202	39,076
3.41	1,294	40,370
3.41	1,864	42,234
3.55	3,861	46,095
3.57	1,142	47,237
3.57	2,390	49,627
3.61	1,681	51,308
3.65	468	51,776[a]

[a] The difference between this total and the total in Table 5, Col. 1 results because minor quantities sold intermittently by some plants were omitted for ease in the supply analysis. The discrepancy of 3,792,000 pounds was later added in at the median price of $3.25.

Sources: Col. 1: Price paid by the various manufacturing plants to each distributor less estimated cost of transportation plus estimated transport cost from the distributors to the proposed new plant at Salisbury.
Col. 2: Total milk available at the corresponding prices.

The supply schedule is graphed in Figure 3. It appears that considerable quantities of milk would be available to the plant at prices of $3.25 per cwt. or below. However, it would take prices up to $3.65 per cwt. to attract some of the milk located farthest from Salisbury.

The feasibility of the plant would depend somewhat on whether it could attract the milk from each distributor by paying the supply prices required by each distributor or whether the plant would have to pay a uniform price for all milk. For example, the total supply of 55,568,000 pounds of 4 percent milk would cost only $1,836,044 if each distributor required merely the price he is now receiving. However, if

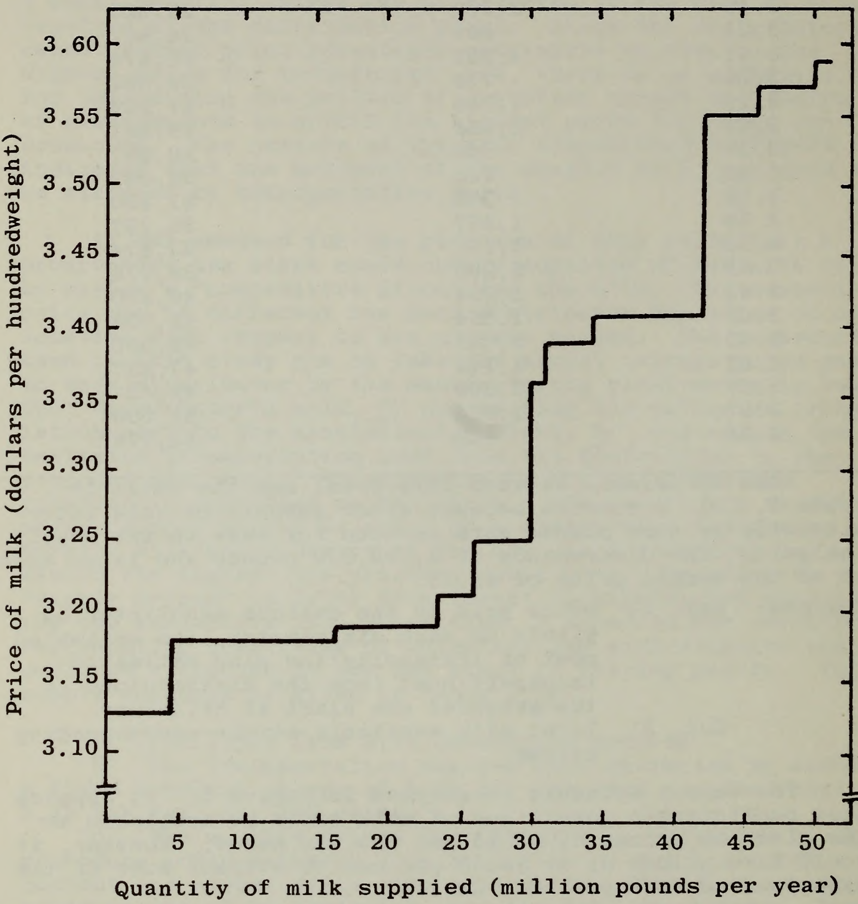

Figure 3. Quantities of surplus milk available at various prices

the new plant found itself in a competitive position of having to pay each distributor the same price, the total supply would be available at a single price of $3.65 and would cost $2,028,232. The former policy could probably be pursued with considerable success, unless the new plant met considerable competitive opposition.

The supply schedule would shift up or down depending on the level of government supports. This would not affect the feasibility of the plant. If the price of manufacturing milk changes, there should be corresponding changes in the price of manufactured products, so absolute processing margins and the expected profitability of the plant would remain largely unaffected. A more serious factor affecting the feasibility of the plant would be the reaction of the manufacturing plants now purchasing this milk. They might increase their paying price if faced with the loss of their supplies. The additional amount which they could pay would depend on their present processing margins and the extent to which their unit costs would increase at lower volumes. The extent of the effects of such competitive bidding on the price of raw milk is not estimated in this study.11/

THE VALUE OF MANUFACTURED PRODUCTS

The value of the various products obtainable from 100 pounds of milk depends on (1) the quantity of the products which can be produced per 100 pounds of milk and (2) the market prices of the products.

Yield of Products per 100 Pounds of Milk

Quantities of processed products per 100 pounds of milk depends on the butterfat and solids content of the milk. Many experiments have been conducted to analyze relationships between the solids content of raw milk and the yield of manufactured products. The particular yield relationships used in this study are: 12/

11/ It should be pointed out that an increase in buying prices by other manufacturing plants would not affect the feasibility of the new plant if it were owned by the producers since their Class III price would be increased. While the net income statement of the plant would be reduced, the net income of the producers themselves would be increased. For this reason, surplus milk plants which are most successful over the long run are frequently owned wholly or in part by the producers themselves.

12/ A discussion of the experimental environment which underlies these yield equations is given in James B. Hassler, "Pricing Efficiency in the Manufactured Dairy Products Industry," Hilgardia, Vol. 22, No. 8, 1953, University of California, Berkeley, California. In deriving these yield equations, Hassler allowed for a product loss averaging 2 percent.

$Q_{40} = 2.5063F - 0.2506$

$Q_{cs} = 0.8401F + 23.4710$

$Q_{cc} = 2.2556F + 1.4000$

$Q_{ns} = 0.3975F + 7.1703$

$Q_b = 1.2267F - 0.1227$

$Q_{dbm} = 0.1668F - .1323$

where

Q_{40} = quantity of 40 percent cream

Q_{cs} = quantity of condensed skim, 30 percent solids

Q_{cc} = quantity of cheddar cheese

Q_{ns} = quantity of nonfat dry solids

Q_b = quantity of butter

Q_{dbm} = dry buttermilk

F = butterfat content of raw milk

The average butterfat content of North Carolina Grade A milk has been decreasing in recent years and may continue to decrease gradually for several more years. There are some indications, however, that the average butterfat content is beginning to stabilize. The decrease has been slow in the last two or three years and the average butterfat content in August (the month with the lowest butterfat content) is approaching the minimum legal content of 3.6 percent for fluid milk. North Carolina herds are now comprised of approximately 71 percent Holstein. 13/ It was assumed that the butterfat content of milk in North Carolina had about reached a constant level. Therefore, the butterfat figures used to predict yields of products were the average butterfat content by months for 1961 for all North Carolina Grade A milk. Estimated yields of the products per 100 pounds of raw milk are given in Table 4.

Prices of Products

The appropriate market prices at which to value these products should be competitive with the delivered price for products of similar quality available to the various plants

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13/ This estimate was derived from a mail questionnaire returned by 54 percent of all producers.

Table 4. Yield of manufactured products per 100 pounds of raw milk of varying fat content

Month	Average butter-fat test (lbs.) (1)	Yield of products per 100 pounds of milk: 40% cream (lbs.) (2)	36% cond. skim (lbs.) (3)	Butter (lbs.) (4)	Powder (lbs.) (5)	Dry butter-milk (lbs.) (6)	Cheddar cheese (lbs.) (7)
Jan.	3.97	9.73	22.34	4.75	8.75	.53	10.3
Feb.	3.93	9.63	22.31	4.70	8.73	.52	10.3
March	3.85	9.43	22.26	4.60	8.70	.51	10.1
April	3.82	9.36	22.23	4.56	8.69	.50	10.0
May	3.77	9.23	22.20	4.50	8.67	.50	9.9
June	3.75	9.18	22.18	4.48	8.66	.49	9.9
July	3.73	9.13	22.17	4.45	8.65	.49	9.8
Aug.	3.69	9.03	22.14	4.40	8.64	.48	9.7
Sept.	3.69	9.03	22.14	4.40	8.64	.48	9.7
Oct.	3.83	9.38	22.24	4.58	8.69	.50	10.0
Nov.	3.87	9.48	22.27	4.62	8.71	.51	10.1
Dec.	3.94	9.66	22.32	4.71	8.74	.53	10.3

Source: Estimating equations on p. 18.

from out-of-state sources. Theoretically, the competitive price could be different for every prospective customer depending on his location in relation to his best supply sources.

To simplify the analysis the price used for condensed skim and nonfat powder for the prospective new plant was the average "delivered" price for products paid by distributors in the Piedmont area of North Carolina. This information was available from plant records. The price used for condensed skim was 16 cents per pound of solids, and for nonfat powder the price used was 17.5 cents per pound.14/ The monthly prices for butter, cheddar cheese and dry buttermilk were based on the 1961 average prices listed in USDA Agricultural Marketing Service Statistical Bulletins.15/ These prices are given in Table 5.

The price for fluid cream varied significantly between buyers and sources, and an "average" price for cream was

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14/ Both high-heat and low-heat powder are imported into North Carolina at the present time. The relative proportions of these two types of powder are not accurately known. The figure of 17.5 cents per pound represents a rough average between the prices of high-heat and low-heat powder.

15/ USDA, Dairy and Poultry Market Statistics, 1961, Statistical Bulletin No. 306, March, 1962.

Table 5. Prices of butter, cheddar cheese and dry buttermilk

Month	Butter price per pound (cents) (1)	Cheddar cheese price per pound (cents) (2)	Dry buttermilk price per pound (cents) (3)
Jan.	56.13	39.79	8.90
Feb.	56.12	37.75	7.80
March	56.20	38.64	7.75
April	56.20	38.85	7.75
May	56.25	37.77	7.75
June	56.25	37.77	7.75
July	56.25	38.40	7.70
Aug.	56.40	38.79	7.75
Sept.	56.41	39.15	7.75
Oct.	56.34	39.29	8.35
Nov.	56.13	39.26	8.60
Dec.	56.13	39.07	9.00

Sources: Col. 1: Average wholesale selling prices at New York, 92 score Grade A butter as listed in USDA, Dairy and Poultry Market Statistics, 1961, Statistical Bulletin No. 306, March, 1962. An estimated two cents per pound transportation charge from North Carolina to New York was subtracted, as well as an estimated brokerage charge of three cents per pound.

Col. 2: Average wholesale selling prices at New York for fresh single daisies. An estimated 1.7 cents per pound was subtracted for transportation and two cents per pound for brokerage charges.

Col. 3: Wholesale selling price in 100-pound bags at Chicago of dry buttermilk for animal feed less 2.5 cents per pound for shipping and brokerage fee.

considered too inaccurate for purposes of evaluating expected revenue from the sale of cream. Hence, a separate price was used for each distributor who bought cream in 1961. Price data were available from individual plant records. Expected revenue from cream was estimated by multiplying the 1961 purchases of each major cream buyer by the price at which he bought cream. This was done for each month in 1961.

FEASIBILITY OF BUTTER-POWDER PLANT

Description of Plant

A butter-powder plant with a 20,000 gallon processing capacity per 8-hour shift was considered the largest plant which could be considered economically feasible in view of present quantities of surplus milk. A plant this size could easily process all of the surplus milk currently available in the state.

It was assumed that milk will be received in bulk from other distribution plants and in some cases diverted directly from farm assembly routes. Raw milk storage capacity at the prospective plant totals approximately two days receipts. It is assumed that the plant will operate on a separate and individual basis with its own administrative staff. It is further assumed that the plant can operate 60 hours per week without double shifting. Working time in excess of 48 hours is reimbursed at the rate of time and a half. Working time in excess of 60 hours per week requires two shifts. These assumptions conform to methods actually being used by similar plants in the Southeast.

The plant has some flexibility in that it can sell fluid cream and condensed skim or can further process the fat into butter and the skim into nonfat powder. Since the market for fluid cream and condensed skim is not well defined, it is impossible to predict accurately the quantities of these products which can be sold at various prices. Consequently, the revenue and cost picture for the prospective plant was first analyzed under the assumption that all of the butterfat and nonfat solids were sold as butter and powder. The results were later modified to provide for the sale of fluid cream and condensed skim. The cost and revenue picture was recomputed accordingly.

Costs of Processing

The method used in this study to estimate processing costs is similar to that which would be used by a prospective owner. The steps followed were:

1. The products to be manufactured were specified, and the hourly volume to be processed was selected.

2. Processing equipment was selected to handle the hourly volume efficiently. Key pieces of equipment were selected first and the remaining items were selected to harmonize efficiently with the hourly capacity of the key pieces. Sales engineers from the major food equipment companies helped in selecting items of equipment and in providing price information. The installed price for each item of equipment was allocated over its expected life to obtain an estimate of annual depreciation. Interest on the investment, taxes, insurance, and repairs were estimated at 30

percent, 16/ 1.2 percent, 1.0 percent and 4.0 percent, respectively, of the initial equipment cost. These costs were added to depreciation to obtain an estimate of total annual fixed costs.17/

3. Initial building costs were estimated by an architectural firm in Chicago which specializes in the design of dairy plants. Their estimates of Chicago costs were adjusted to North Carolina rates with the aid of a Dow Calculator, a publication by F. W. Dodge Corporation which compares building costs in various regions of the United States.

4. Labor requirements to operate the plants were estimated by observing labor crews in plants of similar types and sizes, by using labor standards when available in other published research studies and by considering recommendations by equipment manufacturers. Wage rates to be applied to these physical labor requirements closely approximated those paid by several North Carolina plants for similar types of skills.

5. Utilities costs were estimated by considering horsepower and steam requirements of the plant, translating these requirements into terms of kilowatt hours and fuel requirements and applying rate schedules of North Carolina utility companies to the requirements.

6. Cost estimates of office, laboratory and shop supplies were adapted from other research studies.

7. Packaging costs were estimated from plant records of plants operating in North Carolina and neighboring states.

Equipment Requirements and Costs. The key pieces of equipment in the plant are the evaporator and dryer. For purposes of analysis a double-effect evaporator was selected. The evaporator is powered by two twelve-cylinder heat pumps

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16/ Equivalent to approximately 5.5 percent on the unpaid balance of the loan.

17/ Fixed cost is a term used in this report to specify those cost items which are incurred at a constant rate over the lifetime of the equipment regardless of the volume processed in any particular time period.

driven by natural gas.[18] The rated operating capacity of the unit is approximately 22,000 pounds of fluid skim milk per hour, when the raw milk of 8.8 percent solids is reduced to 45 percent solids.

Auxiliary equipment was selected to harmonize in hourly capacity with the evaporator-dryer unit. All of the significant items of equipment, their purchase costs, estimated life and annual depreciation are given in Table 6. Installation charges were assumed to be 20 percent of the list price. Annual equipment costs are estimated to be $130,131. This includes depreciation, repairs, interest, taxes and insurance.

Building Costs. The area of the building was estimated at 14,400 square feet. The major areas of the building and their approximate dimensions are the butter making room, 30 x 40; butter storage, 40 x 50; condensing-drying room, 50 x 50; powder storage, 40 x 60; compressor room and machine shop, 50 x 50; office, 15 x 30; receiving room, 50 x 40; laboratory, 10 x 20; miscellaneous dry storage, 20 x 20; and separating and cream storage room, 20 x 30.

An itemized list of estimated building costs is given in Table 7. Total building costs are estimated at $220,000, or approximately $14.50 per square foot. Building costs may vary a good deal depending on the desired attractiveness of the building, the slope of the land and many other factors. Consequently, these estimates should be regarded as tentative.

The estimated physical life of the building was estimated for depreciation purposes as twenty years. Annual repairs, interest on the initial investment, insurance and taxes were estimated at rates of 2.0 percent, 3.5 percent, 1.0 percent and 1.2 percent of the initial investment.

Land Costs. It was assumed that 2 1/2 acres of land would be required for building space, landscaping and parking space for employees and visitors, and space to maneuver trucks. Initial costs of land were assumed to be $10,000 per acre. Annual costs would be interest on the investment and taxes.

Labor Costs. Labor for operating the condensing-drying section of the plant is assumed to require five men per shift.

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[18] Costs of a boiler-steam operated evaporator were also analyzed. As compared with the heat pump equipment, the steam evaporator equipment entailed about $80,000 less initial investment but had slightly higher operating costs per hour and higher operating temperatures (which may affect the quality of the product). Also, for intermittent operation in slack seasons, the boilers are not as quickly and efficiently put into operation as heat pumps. The actual selection of the equipment would probably depend on the particular desires of the management rather than on a clearly demonstrated superiority of either type of equipment.

Table 6. Equipment list, initial cost and annual depreciation for butter-powder plant

Item and description	Initial cost (dollars)	Estimated life (years)	Annual depreciation (dollars)
Receiving stage			
Pump to unload trucks	500	15	33
Milk storage tanks, vertical cold wall, 12,000 gal. capacity (4)	48,000	20	2,400
Positive milk pump, 30,000 lbs. per hour variable speed 5 1/2 h.p.	2,500	10	250
Sanitary pipe and fittings	3,200	10	320
Spray ball cleaner for trucks	540	10	54
CIP system	20,000	10	2,000
Sweet water cooling system, 20 h.p. compressor mounted on ice maker	8,000	20	400
1 25 h.p. low pressure boiler	5,000	10	500
	87,740		5,957
Separating stage			
Separators, 10,000 lbs. per hour, cold milk at $9,450 (3)	28,350	15	1,890
Spare separator motor	378	15	25
Schlueter tank 7' long	2,500	15	167
Chain hoist and truck	550	10	55
Sanitary lines	1,600	10	160
	33,378		2,297
Cream storage stage			
Cream storage tank, 2,000 gal. (2)	12,000	20	600
Pump (2)	800	15	53
Regenerator plant heater for pasteurizing and cooling cream	3,500	10	350
Can filler	1,325	10	133
	17,625		1,136
Butter operation (7,200 lbs. daily capacity)			
Butter churn, 800 gal. capacity (2)	25,000	10	2,500
Butter boats (2)	2,000	10	200
Buttermilk pump	400	10	40
Buttermilk storage tank (3,000 gal.)	7,000	20	350
Butter packer	10,000	10	1,000
	44,400		4,090
Skim condensing			
Skim storage tanks, 5,000 gal. (5)	42,500	20	2,125
Pump	500	15	33
HTST pasteurizer, with accessories	15,963	10	1,596

Table 6 (continued)

Item and description	Initial cost (dollars)	Estimated life (years)	Annual depreciation (dollars)
Vacuum pan, 22,000 lbs. milk per hour with accessories	168,465	10	16,847
Sanitary pipe and fittings	7,000	10	700
Plate cooler, for cooling condensed skim	3,500	15	233
Condensed skim storage, 3,000 gal. cold wall tanks	12,680	20	634
Pump, 3 h.p. positive, 22,000 lbs. per hour	2,041	15	136
	252,649		22,304
Powder operation			
Surge tank from pan	5,000	15	333
Concentrate preheater, with accessories	4,768	10	477
10 h.p. boiler for redrying powder	4,000	20	200
Spray dryer 2,000 lbs. per hour with powder filler and Y-bagger	110,625	10	11,063
Heat salvage accessories	3,453	10	345
	127,846		12,418
Bulk tank trucks for delivering products (2)	40,000	7	5,555
Total equipment	603,638	Total deprec.	53,757
Installation	116,728	Installation	10,330
Freight	5,000		
	725,366		63,397

One man is specified for receiving, one for separation and pasteurizing, one to operate the evaporator and dryer, one to bag powder and one for miscellaneous work. The butter operation requires three men: a buttermaker, an assistant buttermaker, and a man to pack the butter into boxes and place the butter into storage. It is assumed that sales and purchases will be handled by the manager.

Two additional workers are required for cleaning and one for the laboratory. A manager, a plant superintendent and two secretaries complete the labor requirements. A list of each job requirement and its accompanying wage rate is given in Table 8. Labor requirements are based on observations of labor crews of similar operating plants.

Table 7. Estimates of building costs, butter-powder plant

Item	Unit	Number of units required	Cost per unit (dollars)	Initial cost (dollars)
Excavation, including backfill and grading	cubic yd.	325	2.55	8,287
Concrete footings and foundation walls	cubic yd.	108	40.00	4,320
Concrete floor	square ft.	14,400	1.00	14,400
Structural steel	tons	75	280.00	21,000
Masonry				
8" concrete block	square ft.	8,300	.60	4,980
4" concrete block	square ft.	8,600	.50	4,300
2" glazed tile	square ft.	6,170	1.40	8,638
Face brick	square ft.	1,900	1.00	1,900
Roof deck, pre-cost concrete	square ft.	14,400	1.00	14,400
Roofing insulation and sheet metal	allowance	-	-	5,800
Cold storage insulation				
Ceiling	board ft.	3,000	.25	750
Wall	board ft.	9,000	.25	2,250
Doors, refrigerated	-	2	400.00	800
Suspended ceiling (offices and lab)	square ft.	1,000	.40	400
Miscellaneous doors	allowance	-	-	3,500
Windows or glass block	allowance	-	-	2,500
Dairy brick flooring	square ft.	3,500	2.75	9,625
Ceramic tile, floor and wall	square ft.	2,000	1.10	2,200
Vinyl, asbestos floor	square ft.	1,000	.55	550
Heating and ventilating	allowance	-	-	18,000
Plumbing and drainage	allowance	-	-	18,000
Refrigeration	allowance	-	-	7,000
Electrical and power work	allowance	-	-	12,000
Contingencies	allowance	-	-	7,000
Scales, 50-ton capacity	-	1	10,000.00	10,000
Side improvement, paving, landscaping	allowance	-	-	25,000
Architect fees	-	-	-	11,000
Total				218,600

Table 8. Labor requirements and costs for typical 8-hour shift, butter-powder plant

Job description	Number of men (1)	Hourly wage (dollars) (2)	Total annual labor costs (dollars) (3)
Receive milk	1	1.40/hour	3,500
Separating and pasteurizing	1	1.40/hour	3,500
Evaporating and drying	1	1.40/hour	3,500
Bagging powder	1	1.40/hour	3,500
Buttermaker	1	2.45/hour	6,150
Assistant buttermaker	1	1.50/hour	4,600
Butter packager and shipping clerk	1	1.40/hour	3,500
Laboratory	1	82.50/week	4,300
Cleaning crew	2	1.40/hour	7,000
Miscellaneous	1	1.40/hour	3,500
Plant superintendent	1	-	8,000
Secretaries	2	325/month	7,800
Total	14	Total	58,850

Sources: Col. 1: Recommendations of equipment manufacturers and observation of labor crews in existing plants of similar nature.
Col. 2: Includes 10 percent for fringe benefits.
Col. 3: Col. 1 x Col. 2 x 48 hours per week for 52 weeks.

Due to the automatic nature of the equipment, labor requirements are less than for other types of plants. Table 8 indicates an annual labor cost rate of $58,850 for a one-shift operation. Actual annual labor costs under the operating conditions specified are larger during months of peak receipts, since overtime and double shifting are required. Two shifts are required in April, May, June and December. The only positions for which two shifts are required are the raw milk receiver, separator-pasteurizer worker, the evaporator-dryer equipment operator and the powder-bagger. Double shifts in these positions for the four months add $4,664 to the annual labor costs. This assumed that labor can be hired during these months only for no significant increase in wage rates.

Utility Costs. Natural gas is used to power the heat pumps in the evaporator operation, to heat the precipitation chamber in the drying operation, to operate the small boiler in the powder redrying operation, and to heat the office and laboratory areas of the building. Natural gas requirements and costs for the evaporator and dryer by months for the butter-powder operation are given in Table 9.

Table 9. Gas requirements for a butter-powder plant when no cream or condensed skim is sold

Month	Quantity of skim and buttermilk produced (1,000 lbs.) (1)	Hours of operation per month (2)	Gas requirements for evaporator and dryer (cu. ft.) (3)	Gas costs (dollars) (4)	Electrical requirements for evaporator and dryer (kwh) (5)	Electrical costs for evaporator and dryer (dollars) (6)	Electrical costs for rest of plant (dollars) (7)
Jan.	3,492	158.7	1,170,412	1,058.33	28,566	471.03	208.56
Feb.	2,683	122.0	899,750	841.80	21,960	418.18	188.50
March	3,519	160.0	1,180,000	1,066.00	28,800	472.90	210.38
April	5,585	253.9	1,872,513	1,620.01	45,702	608.12	281.52
May	7,480	340.0	2,507,500	2,128.00	61,200	732.10	345.36
June	5,685	258.4	1,905,700	1,646.56	46,512	614.60	285.17
July	3,247	147.6	1,088,550	992.84	26,568	455.04	199.44
Aug.	3,393	154.2	1,137,225	1,031.78	27,756	464.55	208.56
Sept.	2,358	107.2	790,600	754.48	19,296	395.46	170.26
Oct.	2,774	126.1	929,987	865.99	22,698	424.08	184.85
Nov.	4,387	199.4	1,470,575	1,298.46	35,892	529.64	237.74
Dec.	8,222	373.7	2,756,038	2,326.83	67,266	780.63	372.72
Total				15,631.08		6,366.33	2,893.06

Sources: Col. 1: Total raw milk receipts minus the quantity of cream removed plus the quantity of buttermilk from the butter operation.

Col. 2: Col. 1 divided by the evaporator capacity of 22,000 pounds per hour.

Col. 3: Col. 2 multiplied by 7,375 cubic feet of gas per hour.

Col. 4: Based on rate schedule in Table 10.

Col. 5: Col. 2 multiplied by 180 kwh per hour.

Col. 6: Col. 5 multiplied by rate schedule in Table 11.

Col. 7: Estimated requirements and costs for remainder of plant as adapted from D. A. Clark, Jr. Class III Milk in the New York Milkshed: III, Costs of Manufacturing Dairy Products, USDA Marketing Research Report No. 400, May, 1960.

In some months, daily operation is not feasible due to short supplies of milk. In February, September and October, the months of lighest surplus, it would probably be more economical to evaporate every other day. Every other day operation when it is feasible would substantially reduce cleaning costs. Gas and electricity requirements would also be slightly reduced with fewer "warming up periods" for the equipment. Estimates of gas and electricity costs are therefore based on every-other-day operation for the equipment during the months mentioned.

The evaporator uses 2,775 cubic feet of gas per hour of operation and the dryer uses 4,600 cubic feet of gas per hour. It is assumed that the heated areas of the building can be heated with an average of 100,000 cubic feet of gas per month, or an additional eighty dollars per month. The 20 horsepower boiler is assumed to require $500 worth of gas per year. Total annual natural gas requirements are then $17,091 for the entire plant. These cost estimates are based on the rate schedule in Table 10.

Electricity is used to drive the power equipment, and for lighting the building. While the evaporator is operating it requires 80 kwh per hour. The dryer requires 100 kwh per hour. Electricity requirements and costs by months are also given in Table 9. Electricity costs are based on the rate schedule in Table 11.

Costs for Office, Shop and Laboratory Equipment and Supplies. Office equipment, such as adding machines, calculators, desks and tables, etc., varies a good deal among plants. Hence, it was not considered feasible to do extensive research to determine such costs accurately. The same situation applies to laboratory equipment such as glassware, sterilizer, etc., and shop equipment for minor repairs. Estimates for these costs were adapted from work done by D. A. Clarke.19/ Clarke estimates total investment in office equipment at $27,375, investment in laboratory equipment at $15,218 and investment in shop equipment at $13,283. In terms of average annual lifetime costs, these investments total $5,246 for depreciation, $1,676 for interest, $587 for taxes and $447 for insurance. Annual laboratory supplies such as broken glass replacement, test chemicals, etc., are estimated at $1,500 and annual office supplies such as records, stamps, etc., are estimated at $5,000 per year. Total annual miscellaneous costs then are estimated to be $14,500.

Cost Summary. Estimated total annual costs are summarized in Table 12. Costs per hundred pounds are approximately $.60. Annual equipment costs represent the largest single component, being about 41 percent of the total. Labor costs represent

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19/ D. A. Clarke, Jr., *Class III Milk in the New York Milkshed: III, Costs of Manufacturing Dairy Products*, USDA Marketing Research Report No. 400, May, 1960.

Table 10. Rate schedule for natural gas

First	1,000	cu. feet at	$ .315 per C
Next	1,000	cu. feet at	.215 per C
Next	8,000	cu. feet at	.165 per C
Next	15,000	cu. feet at	.14 per C
Next	50,000	cu. feet at	.12 per C
Next	125,000	cu. feet at	.11 per C
Next	300,000	cu. feet at	.095 per C
All over	500,000	cu. feet at	.080 per C

Table 11. Rate schedule for electricity

Billing demand[a]

$1.50 per kwh for the first 25 kwh
$1.20 per kwh for the next 25 kwh
$1.10 per kwh for the next 50 kwh
$1.00 per kwh for the rest

Energy charge

$.010 for the first 20,000 kwh
$.008 for the next 50,000 kwh
$.007 for the next 100,000 kwh
$.006 for the next 200,000 kwh
$.005 for the rest

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[a] Billing demand is a technical term used to describe the number of kilowatts used during a fifteen minute period of peak load.

about 19 percent of the total. The comparatively low proportion of costs made up by labor means that seasonal variations in milk supplies will not be a serious factor in the feasibility of the plant. The important factor is the total annual quantity of milk processed through the plant. The high fixed equipment costs must be spread over a large volume of milk.

Expected Net Revenues. Estimates of the total revenue available from the sale of butter, nonfat powder and dry buttermilk are developed in Table 13. These estimates are based on the quantity of milk received, the yield of products manufactured from raw milk and the competitive price for the products. The estimate of total revenue is $2,295,380. The cost of the raw milk as estimated from Table 3 and adjusted for monthly average butterfat content is $1,777,832. Subtracting the cost of raw milk from the value of the products leaves $517,548 to cover the cost of processing. Since the

Table 12. Summary of total annual costs for producing butter, nonfat powder and dry buttermilk

Cost component	Costs (dollars)	Cost per cwt. (dollars)
Building - $218,600 initial cost		
Depreciation (20-year life)	11,000	
Repairs	4,400	
Interest	6,558	
Taxes	2,305	
Insurance	1,760	
Total	26,023	.047
Equipment - $725,366 initial cost		
Depreciation	63,397	
Repairs (4 percent)	29,015	
Interest (3 percent of initial investment)	21,761	
Taxes (1.2 percent)	8,704	
Insurance (1.0 percent)	7,254	
Total	130,131	.242
Land - $25,000 initial cost		
Interest	750	
Taxes	300	
Total	1,050	.002
Utilities		
Electricity	9,260	
Gas	17,091	
Water	500	
Cleaning	3,120	
Total	29,971	.053
Labor	64,314	.116
Manager	15,000	.027
Packaging	45,549	.082
Office and lab supplies	14,500	.026
Total annual costs	326,538	.595

estimated cost of processing is $326,538, estimated profit is $191,010. At this rate, the initial investment of $960,000 could be repaid in approximately five years. Estimated profit amounts to about $.34 per hundred pounds of milk processed. A summary of the profit-loss statement is given in Table 14.

Additional Profits from the Sale of Cream and Condensed Skim. In view of the substantial quantities of fluid cream and condensed skim imported in 1961, it is possible that the prospective new butter-powder plant would be able to compete

Table 13. Revenue from sale of butter, nonfat powder and dry buttermilk

Month	Raw milk receipts (1,000 lbs. milk) (1)	Revenue from butter (dollars) (2)	Revenue from nonfat powder (dollars) (3)	Revenue from dry buttermilk (dollars) (4)
Jan.	3,664	97,689	56,105	1,728
Feb.	2,818	74,329	43,052	1,143
March	3,700	95,652	56,240	1,462
April	5,879	150,662	89,405	2,277
May	7,873	199,285	119,453	3,051
June	5,990	150,948	90,778	2,275
July	3,417	85,532	51,725	1,289
Aug.	3,584	88,941	54,190	1,333
Sept.	2,482	61,604	37,528	923
Oct.	2,920	75,347	44,406	1,219
Nov.	4,613	119,625	70,314	2,023
Dec.	8,620	227,889	131,843	4,115
Total	55,568	1,427,503	845,039	22,838

Source: Yields per cwt. of milk (from Table 3) was multiplied by number of pounds of milk received (Col. 1) to estimate quantity of butter and nonfat powder produced. Quantities produced were multiplied by the prices in Table 5 to obtain estimates of total revenue.

Table 14. Profit-loss statement, butter-powder plant, without sales of fluid cream and condensed skim

REVENUES	
Butter	$1,427,503
Powder	845,039
Dry buttermilk	22,838
Total	$2,295,380
COSTS	
Raw milk	$1,777,832
Processing cost	326,538
Total	$2,104,370
PROFIT	$ 191,010

effectively for some of these sales. By doing so, it could dispose of butterfat at considerably higher prices than would be available from butter markets. Churning costs would be reduced as well as the costs of condensing and drying the buttermilk. The sale of condensed skim would decrease total revenue somewhat since condensed skim is currently priced somewhat below low temperature Grade A nonfat powder. However, processing costs would also be lowered since the skim would not have to be dried.

The change in estimated net revenue by the sale of fluid cream and condensed skim was analyzed. It was assumed that the plant could sell fluid cream in quantities equivalent to approximately 17 million pounds of raw milk per year. This quantity is equivalent to all of the cream imports into the state in 1961. Revenue from the fluid cream was estimated by multiplying the quantities imported by each major cream buyer in 1961 by the prices paid. This information was available from plant records. Under these assumptions, the expected revenue from butterfat was increased about $45,000 per year.

The decrease in revenue from the sale of condensed skim at an assumed price of $.16 per pound of solids for the quantities imported in 1961 was about $54,000. This was a result of the decrease in value of nonfat solids from $.175 per pound as powder to $.160 per pound as liquid. Total revenue from the sale of cream and condensed skim thus decreases by about $9,000 per year. However, the decrease in processing costs obtained by selling the fluid products and avoiding costs of churning and drying almost exactly offsets this decrease in revenue. Consequently, the expected feasibility of the plant is unchanged. The profit-loss statement under these conditions is summarized in Table 15.

Table 15. Profit-loss statement, butter-powder plant, with sales of fluid cream and condensed skim

REVENUES		
Butter	$	995,060
Nonfat powder		554,377
Fluid cream		477,848
Condensed skim		243,462
Total	$	2,286,947
COSTS		
Raw milk	$	1,777,832
Processing costs		319,536
Total	$	2,097,368
PROFIT	$	189,579

Costs and Profits of Operations at Varying Capacities. Since nearly half of the total annual processing costs as computed are fixed regardless of volume, one might expect significantly lower costs with higher volumes. Similarly one would expect average processing costs to increase significantly if volume drops off below 1961 volumes. To illustrate the cost variation with volume, available quantities of surplus milk each month were arbitrarily assumed to increase by 20 percent. Plant receipts were increased accordingly [20] and total annual costs were recomputed. Building costs, land costs, equipment costs and manager's salary were held fixed. Other costs (except labor) were increased by 20 percent. Since labor is ordinarily somewhat related to output, it is normally considered a variable cost. However, a check on the daily hours of operation required to process the increased volume indicated that no additional labor would be required to process the larger quantities. Labor crews had been underutilized at the previous volumes. The increased raw milk receipts were channelled into butter and powder and estimates of annual total revenue were increased accordingly. (It is uncertain that additional powder could be sold at the prices assumed since it would have to be moved to out-of-state markets.) Under these assumptions, total annual processing costs rose to $355,000 or an increase of about 8 percent. Net profits rose to $254,000, an increase of about 36 percent. Average unit processing costs fell to $.53 per hundredweight. Under these conditions the initial investment could be repaid in 3.6 years.

A similar hypothetical illustration was analyzed in which plant receipts were reduced by 20 percent. Here average unit processing costs rose to $.66 per hundredweight and total annual profits fell to $105,000. It would take nearly eight years to repay the initial investment under these conditions.

In conclusion, a plant of this type and size seems quite promising. Much will depend on its ability to attract sufficient available supplies to spread the rather high fixed costs over a large enough volume. It would appear that these relatively high margins available to the plant would enable it to bid successfully for available supplies.

FEASIBILITY OF CHEDDAR CHEESE PLANT

Description of Plant

The cheddar cheese plant was designed to process 10,000 gallons of milk in an eight-hour shift. Milk is received in bulk tanks. Raw milk storage capacity totals approximately two days receipts. The plant is designed to process single daisies only.21/ Cheese will be stored approximately thirty days and sold as fresh cheese at New York wholesale prices. Whey is separated and the fat is sold for use in butter. The nonfat portion of the whey is dumped. It is assumed that the revenue obtained by the sale of fat exactly offsets the cost of disposal of the waste whey. In some areas, soil conditions are such that waste whey can be dumped on fields and the high cost of sewage disposal can be avoided. It might even be possible to sell the whey as hog feed.

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[20] Total plant receipts did not increase by the full 20 percent because the plant was already being operated at full capacity two shifts per day during the months of May and December. It was assumed that the plant turned down receipts during these months.

Costs of Processing

Equipment Costs. The equipment list is given in Table 16. Installation and freight are assumed to be 20 percent of the list price of the equipment. Estimates of useful life of each item of equipment were drawn largely from other published sources and Bulletin F of the U. S. Internal Revenue Service.

Building Costs. The floor plan on which the estimates of building costs were based is given in Figure 4. Floor space totals 13,400 square feet. Building costs were estimated in Table 17 to be $163,000 or approximately $12 per square foot. The expected life of the building is assumed to be 30 years. It is assumed that 1/2 acre of land will be required for the building and driving space for the trucks. Land value is assumed to be $10,000 per acre. The total investment in buildings, equipment and land is $412,600.

Labor Costs. The plant was designed to operate on a one-shift basis six days per week. Labor requirements are given in Table 18. These requirements are based on labor crews in actual cheese plants of similar size. Considerable manual labor is required to process the cheese. Although some experimentation with automation has been done, mechanized methods have not found widespread acceptance. Wage rates for work in a cheese plant are normally higher than in other types of plants because of the relatively high abilities required of the workers.

Nominal wage rates were increased 10 percent to allow for fringe benefits, social security and workmen's compensation. Wage rates and labor requirements are representative of those found in other cheese plants in the southeast.

Utility Costs. Estimates of electricity requirements and water requirements were adapted from a cost study of cheese plants of similar size by D. A. Clarke.22/ Clarke

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21/ A single daisy is a 24-pound hoop.

22/ D. A. Clarke, Jr. Class III Milk in the New York Milkshed: III, Costs of Manufacturing Dairy Products, USDA Marketing Research Report 400, May, 1960.

Table 16. Equipment list, cheddar cheese plant, 10,000-gallon daily capacity

Item	Initial cost (dollars)	Expected life (years)	Annual depreciation (dollars)
Pump to unload trucks, 50,000 lbs./hour (2)	1,200	14	86
Storage tanks, 6,000 gal. (4)	36,800	20	1,840
Load cell (1)	5,370	10	537
Pump to clarifier (separator), variable speed, 17,000 lbs. to 37,000 lbs./hour	800	14	57
Separator-clarifier, 10,000 lbs./hour (2)	18,900	10	1,890
HTST, 20,000 lbs./hour with float tank, controls, circulating unit	15,000	10	1,500
Surge tank, 3,000 gal.	5,500	14	393
Preheater	2,544	10	254
Cheese vats, (6 vats, 15,000 lbs. each)	22,446	20	1,122
Parts washer	800	10	80
Cheese presses, double row, 20 feet (3)	4,500	14	321
Curd mills, 12 in., 3 knife, portable stand (2)	1,480	14	106
Whey pump, 3 h.p.	2,040	16	128
Whey pasteurizer, 100 gal. vat	1,095	20	55
Whey tanks, 5,000 gal. (4)	2,800	15	187
Whey separators, 10,000 lbs./hour (2)	18,900	10	1,890
Wax, machine, tank, heating units, fan	590	20	30
Sanitary lines and fittings	3,435	10	343
Hoop washer	5,000	10	500
Cold storage compressor, 10 h.p.	2,500	15	167
Air compressor, 3/4 h.p.	355	14	25
Steam generator, 150 boiler h.p.	14,000	20	700
Miscellaneous - cheese hoops, curd knives, starter processor, cans, shovels, gate valves, tables	35,945	11	3,268
	202,000		15,479
Installation (20 percent)	40,500	9	3,096
Office and lab equipment	2,125		236
Total investment	244,625		18,811

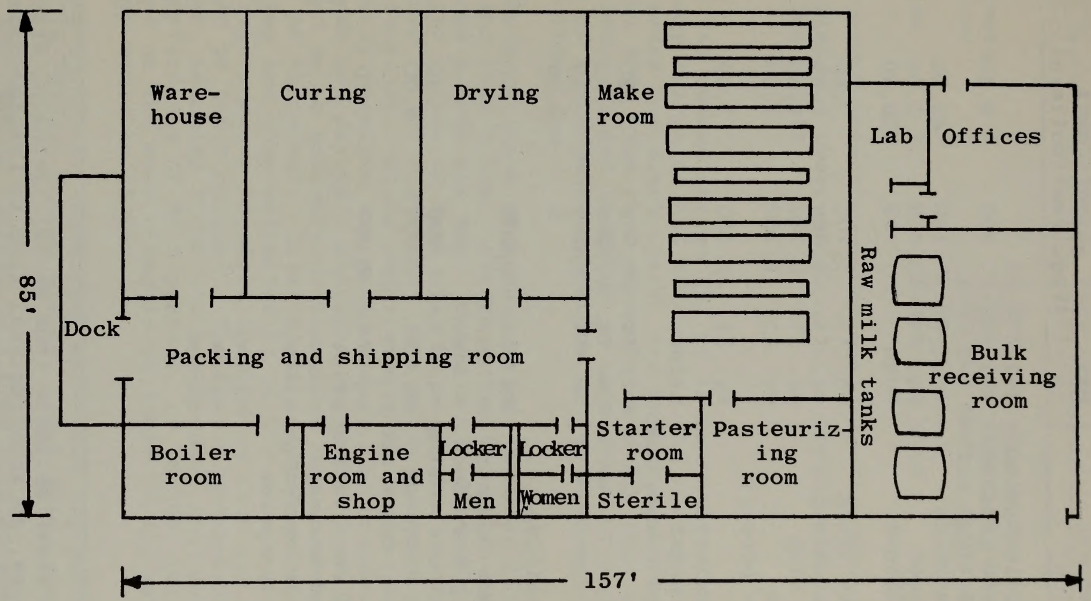

Figure 4. Floor plan for cheddar cheese plant

Table 17. Estimated building requirements and costs, cheddar cheese plant

Item	Unit	Number of units required	Cost per unit (dollars)	Initial cost (dollars)
Excavation, including backfill and grading	cu. yd.	300	2.55	765
Concrete footings and foundation walls	cu. yd.	100	40.00	4,000
Concrete floor	sq. ft.	13,400	1.00	13,400
Structural steel	tons	33	280.00	9,240
Masonry				
8" concrete block	sq. ft.	7,700	.60	4,620
4" concrete block	sq. ft.	8,000	.50	4,000
2" glazed tile	sq. ft.	5,740	1.40	8,040
Face brick	sq. ft.	1,750	1.00	1,750
Roof deck - precast concrete	sq. ft.	13,400	1.00	13,400
Roofing insulation and sheet metal	allow.	-	-	5,000
Cold storage insulation				
Ceiling	bd. ft.	10,000	.25	2,500
Wall	bd. ft.	11,200	.25	2,800
Finish	bd. ft.	5,300	.25	1,325
Doors		2	400.00	800
Suspended ceiling (offices)	sq. ft.	1,000	.40	400
Miscellaneous doors	allow.	-	-	2,200
Windows or glass block	allow.	-	-	2,200
Vinyl asbestos flooring	sq. ft.	1,000	.40	400
Dairy brick flooring	sq. ft.	3,500	2.00	7,000
Ceramic tile, floor and wall	sq. ft.	2,000	1.10	2,200
Heating and ventilating	allow.	-	-	12,000
Plumbing and drainage	allow.	-	-	12,000
Refrigeration equipment	allow.	-	-	7,000
Electrical and power work	allow.	-	-	7,000
Site improvements	allow.	-	-	17,000
Miscellaneous	allow.	-	-	10,000
Subtotal				151,040
Architect fee				12,000
Total				163,040

Source: Itemized estimate from Hertel, Johnson, Eipper and Stopa, an architectural firm in Chicago specializing in the design of dairy plants. The Chicago prices were converted to North Carolina prices with the aid of the Dow Calculator, F. W. Dodge Corporation. This publication lists construction costs for various regions of the United States.

Table 18. Labor requirements and costs for cheddar cheese plant

Job description	Number required	Wage rate	Annual labor cost
		(dollars)	(dollars)
Manager	1	10,000 per year	10,000
Plant foreman	1	7,000 per year	7,000
Cheese maker	1	2.65 per hour	6,600
Workers	7	2.30 per hour	40,293
Secretaries	2	3,500 per year	7,000
Total			70,893

Source: Based on observation of crew organizations in existing plants.

estimates the demand charge 23/ at 42 kilowatts and the average daily energy charge of 383 kilowatts. At average North Carolina rates for electricity, the annual cost for electricity would be $1,890. The rate schedule used for this estimate is found in Table 11 and is based on an average of the rate schedules of three power companies in the Piedmont area of North Carolina.

Clarke's estimate of annual water costs of $579 is accepted for this study. Clarke estimates steam requirements to be 14,884 pounds per day. Using a standard of 112 pounds of steam per gallon of fuel oil, he estimates daily fuel requirements at 132.9 gallons. His plant apparently did not use a pasteurizer. Steam requirements to pasteurize the average daily receipts are estimated in the present study at 1,486 pounds per day.24/ Clarke's estimate of 14,884 pounds is accepted as an estimate of the steam requirements for the remainder of the plant. Total steam requirements including pasteurizing are then estimated at 16,370 pounds per day. The fuel oil requirements required to produce this quantity of steam would be 146.2 gallons. The equivalent quantity of natural gas, assuming 1,000 btu's per cubic foot of gas and a boiler efficiency of 82.5 percent, is 18,129 cubic feet per day. Based on the rate schedule in Table 10 the annual cost of this gas would be $5,955.

Packaging Costs. Packaging materials represent a large cost item in cheddar cheese plants. Each daisy requires a

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23/ The "demand charge" is a term used to mean the peak energy requirements in a given time period, normally a half-hour.

24/ Assumes a HTST regenerator efficiency of 80 percent, a 90 degree temperature rise in milk, a specific heat of milk of .93 and 1,000 btu's per pound of steam.

bandage, two hoops, a box, and four ounces of wax. Bandages cost $45 per thousand, hoops are $40 per thousand and boxes cost $.38 each. This totals approximately $.51 per daisy, or approximately $.21 per 100 pounds of milk received.

Miscellaneous. Approximately 140 gallons of rennet are used per five million pounds of milk received.25/ Rennet costs approximately $16.30 per gallon, or about $.07 per hundred pounds of milk received.

Approximately sixty gallons of color are added per five million pounds of milk received. At $6.50 per gallon, this amounts to slightly less than a cent per 100 pounds of milk received.

Clarke's estimates of $3.79 per day for the cost of cleaning materials, $5.60 per day for office supplies, $3.20 per day for laboratory supplies and $20.29 for "other" supplies are accepted for use in this study. Standard cost data for these items are not available and these estimates represent such fragmentary data as are available from a number of other research studies.

Cost Summary. The cost summary is given in Table 19. Total processing costs per hundredweight of milk received is $.73 or approximately $.07 per pound of cheese.

Costs at Varying Levels of Capacity. The analysis was completed under the assumption that the plant operated at full capacity on a single eight-hour shift six days per week. In view of the highly seasonal nature of surplus milk, it is worthwhile to analyze costs of processing while operating at varying levels of plant capacity. Two additional levels of operation are considered: (1) operation at half capacity, i.e., processing of three vats per day, and (2) two-shift operation, i.e., processing of twelve vats per day.

Substantially different cost levels might be expected when the plant is operating at levels other than single shift full capacity because of the fixed nature of some of the costs. For example, building and equipment costs do not vary substantially with volume of milk processed. Lower processing costs per hundredweight of milk would be expected with a two-shift operation since fixed costs are spread over a higher volume of milk. Operation at less than capacity would result in higher costs per hundredweight.

To estimate the costs of processing per hundredweight of milk received when operating at half capacity, utility costs, packaging costs and miscellaneous costs were cut in half. These costs were judged to be proportional to volume. Costs of equipment, building, and land were held constant.

25/ G. H. Wilster, Practical Cheesemaking, O.S.C. Cooperative Association, Corvallis, Oregon, 1959.

Table 19. Summary of processing costs, cheddar cheese plant

Item	Annual cost	Cost per 100 lbs. raw milk
	(dollars)	(dollars)
Equipment ($244,625 initial investment)		
Depreciation	18,811	
Repair and maintenance (4 percent per year)	9,785	
Interest (3 percent on initial investment)	7,339	
Taxes (1.2 percent)	2,936	
Insurance (1.0 percent)	2,446	
Total	41,317	.13
Building ($163,040 initial investment)		
Depreciation (30-year life)	5,429	
Repair and maintenance (2 percent per year)	3,261	
Interest (3 percent on initial investment)	4,891	
Taxes (1.2 percent)	1,956	
Insurance (1.0 percent)	1,630	
Total	17,167	.06
Land costs		
Interest	150	
Taxes	51	
Total	201	-
Labor	70,893	.24
Packaging	52,826	.18
Utilities		
Electricity	1,890	
Water	579	
Fuel	5,955	
Total	8,424	.03
Miscellaneous		
Rennet and color	13,360	
Cleaning supplies	1,186	
Office supplies	1,753	
Lab supplies	1,001	
Miscellaneous supplies	6,351	
Total	23,651	.08
Grand total	214,479	.73

Labor costs were held constant except that four plant workers were used instead of seven. The assumption underlying this adjustment was that labor could be laid off and rehired without additional cost. Costs of processing per hundredweight under this set of conditions amounted to a total annual cost of $113,466 or $1.00 per hundredweight of milk received.

The estimate of the processing cost per hundredweight of milk when the plant is operated for two shifts daily was accomplished by holding building, equipment and land costs constant. Packaging costs, utility costs and miscellaneous costs were doubled. Wages for the manager, plant foreman and secretarial labor were held constant, and the number of plant workers was doubled. This resulted in an estimate of $.58 per hundredweight of milk processed.

The relationship between cost of processing and utilization of capacity as estimated with the foregoing procedure is illustrated in Figure 5.

Expected Profits in Cheddar Cheese

Processing costs for cheddar cheese production are high compared to other types of processing. The profitability of such an operation, however, depends on the value of the product and the cost of raw milk as well as the cost of processing.

Table 20 shows the expected profitability of the cheddar cheese plant. Average profit is $.07 per hundredweight of raw milk. A low value for the final product and high processing costs cause the expected profit margin to drop to a low figure. This rather disappointing profit potential is probably low enough to discourage investment in this type of plant. This probably explains why so few new cheese plants have been built in recent years.

It is possible that higher profits could be obtained if packaging and curing operations were added to the plant. If a finished product could be sold locally, high brokerage and transportation charges could be avoided. This possibility was not considered in this study.

CONCLUSIONS

Present volumes of North Carolina Grade A milk being sold to evaporated milk and cheese plants are sufficient to construct and maintain a new processing plant large enough to compete successfully with existing markets at current product prices. A butter-powder plant with an 8-hour processing capacity of 20,000 gallons of milk might expect a profit margin of approximately $.34 per hundredweight of milk received. This estimate is based on the assumption that substantially all of the surplus milk now sold to cheese and evaporated milk plants

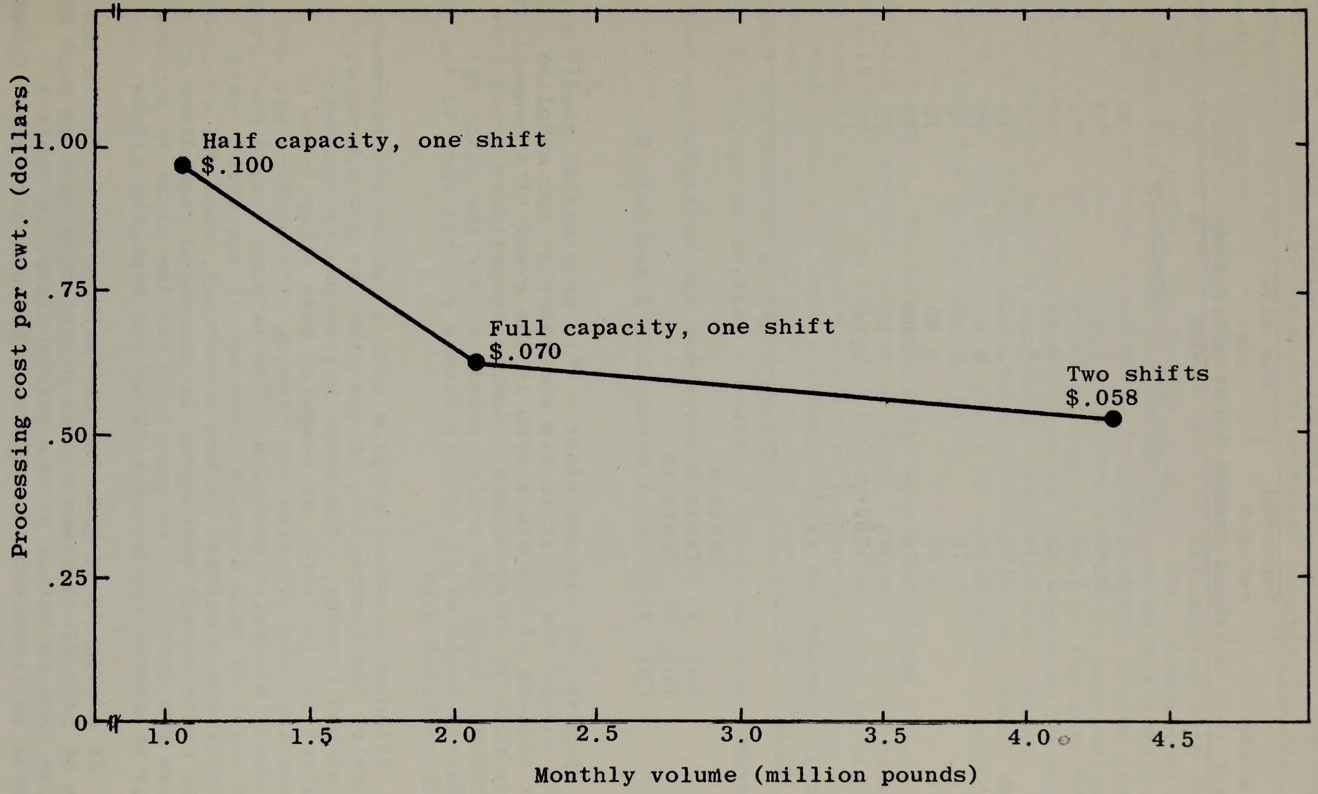

Figure 5. Costs of processing milk into cheddar cheese with varying utilization of capacity

Table 20. Expected profitability of cheese plant

Month	Expected revenue from cheese (1)	Raw milk cost (fat corrected) (2)	Processing cost (3)	Profits (4)
	(dollars per hundredweight of milk)			
Jan.	4.10	3.16	.73	.11
Feb.	3.89	3.14	.73	.02
March	3.90	3.09	.73	.08
April	3.89	3.08	.73	.08
May	3.74	3.04	.73	-.03
June	3.74	3.03	.73	-.01
July	3.76	3.02	.73	-.01
Aug.	3.76	2.99	.73	.04
Sept.	3.80	2.99	.73	.08
Oct.	3.93	3.08	.73	.12
Nov.	4.04	3.10	.73	.21
Dec.	4.02	3.14	.73	.15
Average profits				.07

Sources: Col. 1: Col. 7, Table 4 multiplied by Col. 2, Table 5.
Col. 2: Table 3 corrected for butterfat content.
Col. 3: Table 19.
Col. 4: Col. 1 minus Col. 2 and Col. 3.

was received at the new plant. This substantial profit margin would enable the plant to bid successfully for supplies from most regions of the state even in the event of a competitive price rise by other buyers. Such a competitive price rise would, of course, lower the profit potential for the plant but producers would still benefit from a general rise in the price of Class III-A milk.

Although seasonal surplus milk supplies are extremely variable, the feasibility of the plant is not appreciably diminished thereby. The newer butter-powder equipment requires little labor, as compared with other types of processing, and overtime and "laying off" workers are not seriously expensive problems. The largest single cost component in a plant of this type is fixed annual equipment costs, depreciation, interest on the investment, repairs, etc. Since these costs remain substantially unchanged regardless of volume processed, it is important for the plant to process as large an annual volume of milk as the capacity allows.

If provision is made for the sale of butterfat in the form of bulk fluid cream at the prices discussed on page 20, rather than as butter at the prices listed in Table 4, revenue is increased approximately $45,000 per year. Cream sales are highly seasonal, but cream storage is not feasible since cream sales can be made from fresh receipts in all months of operation.

The cheddar cheese plants analysis indicated that the average expected profit margin was $.07. Compared with the butter-powder plant, the margin is quite low. Labor costs are quite high in cheese processing because of the quantity and quality of labor required. Present support prices for cheese are too low to make investment in cheese processing facilities attractive if the cheese is sold in the form of fresh daisies. Seasonal variation in milk supplies is costly because of the large labor crews, unless trained cheese makers can be readily hired on a seasonal basis. Thus, the analysis was completed for a plant of considerably lower volume than the butter-powder plant.

In summary, the butter-powder operation looks moderately promising at present volumes of milk. Further investigation among industry groups as to feasible ownership and pooling arrangements would appear warranted. Further increases in milk production will make the feasibility of the plant even greater. The instability of a market heavily burdened by surplus may make such action necessary.

Agricultural Experiment Station

North Carolina State College

Raleigh, N. C.

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